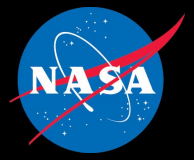
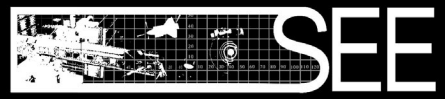
The Synergistic Engineering Environment

http://centauri.larc.nasa.gov/see

June 2005



SEE: What is it?



The Synergistic Engineering Environment is a software tool for space mission visualization and analysis.

Another 3D Visualization Toolkit?

The SEE has followed several development priorities that distinguish it from existing tools:

Enable users to effectively investigate mission events that span very great or very small scales of space and time.

Allow performance models and object geometry of mixed-fidelity to appear in the same virtual environment.

Maintain extensible and multi-platform compatible source code so that the unique requirements of a small group of users can be met without major software architecture changes.

SEE History and Background

Description / Goals

Simulate and visualize space mission scenarios by integrating spacecraft performance models and realistic object geometry in a 3D virtual environment.

Facilitate the understanding of a problem trade space.

Perform spacecraft configuration and system trade studies.

Provide an open, customizable code architecture that can accommodate new models as the system studies advance.

Brief History

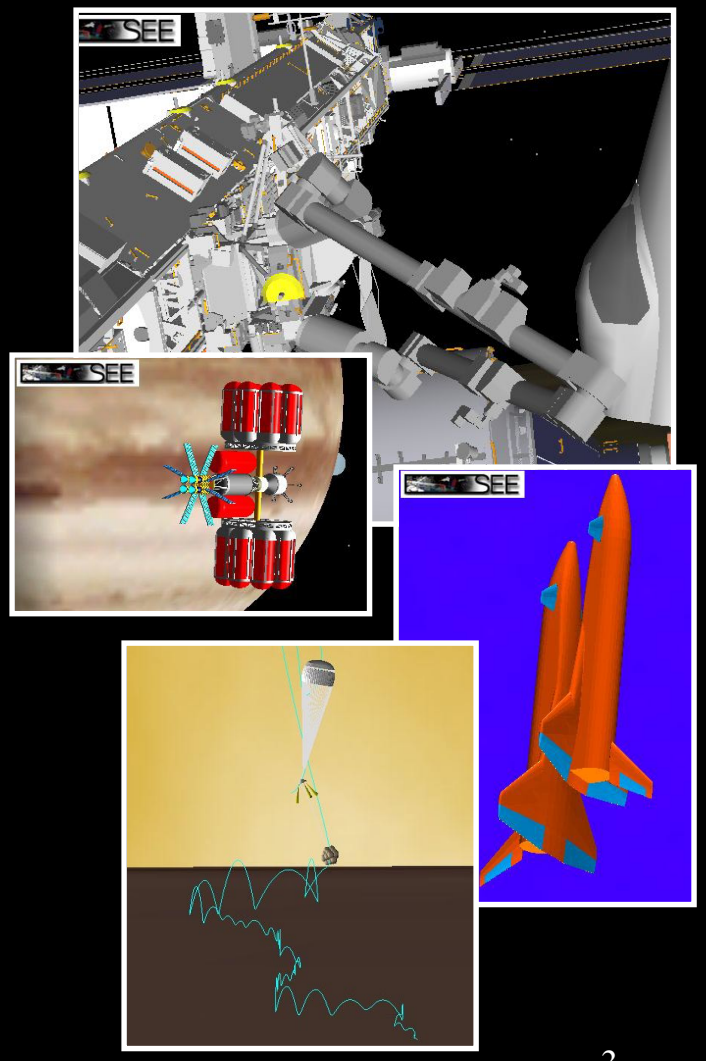
Research initially funded by NASA Chief Engineer and Code M Advanced Programs

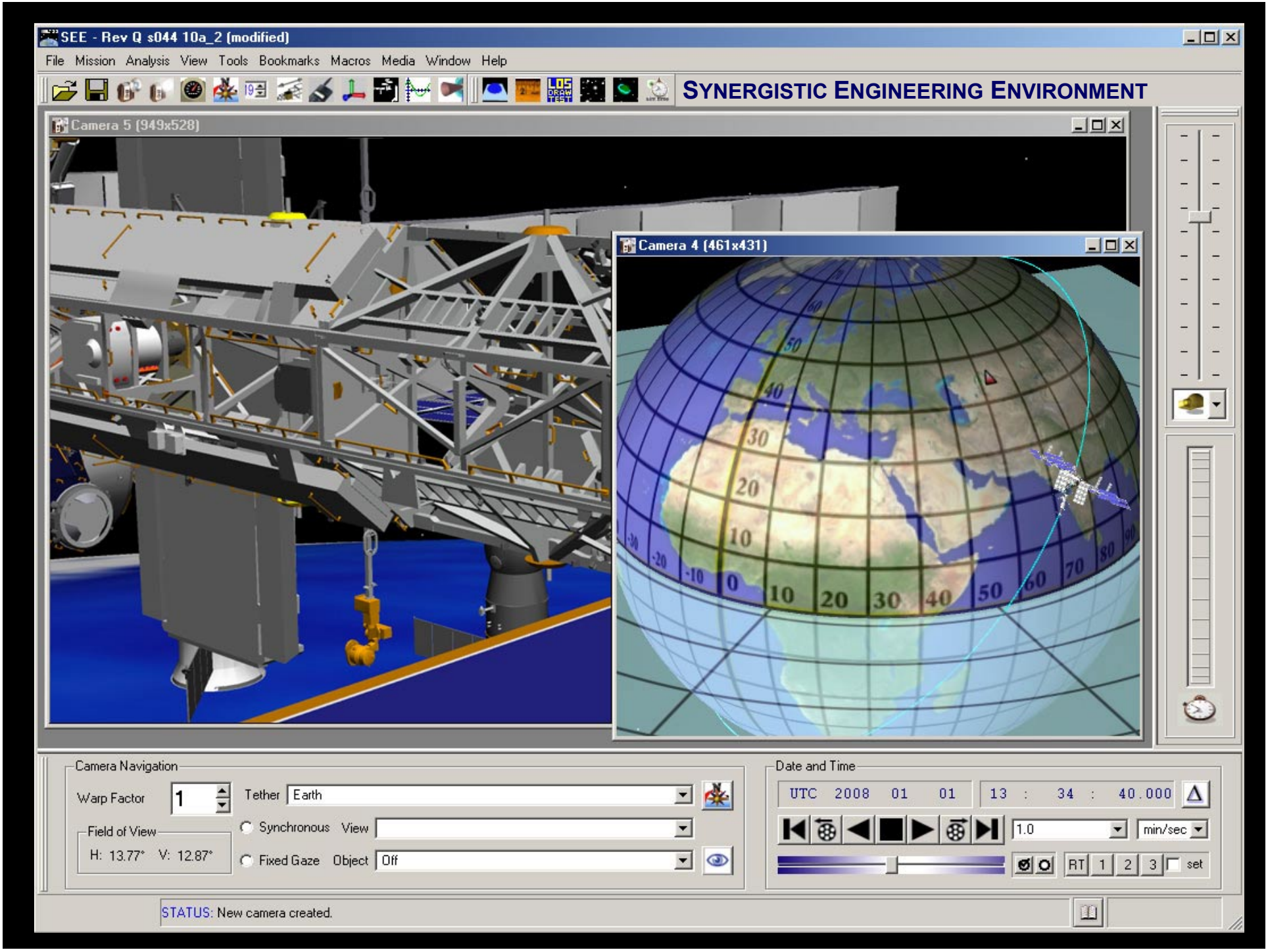
Adopted by Intelligent Synthesis Environment Program as the International Space Station Large Scale Environment

In use by the ISS VIPER team and Mission Operations at JSC

Scope of SEE broadened under Revolutionary Aerospace Systems Concepts and Engineering for Complex Systems

In use by Vehicle Analysis Branch in support of Mars Scout and Next Generation Launch Vehicles




SEE - Rev Q s044 10a_2 (modified)
File Mission Analysis View Tools Bookmarks Macros Media Window Help
SYNERGISTIC ENGINEERING ENVIRONMENT
Camera 5 (949x528)
Camera 4 (461x431)
Camera Navigation
Warp Factor
1
Tether
Earth
Field of View
H: 13.77° V: 12.87°
Synchronous View
Fixed Gaze Object
Off
Date and Time
UTC 2008 01 01
13 : 34 : 40.000
1.0
min/sec
RT 1 2 3 set
STATUS: New camera created.

General Capabilities

True to scale solar system

Effective navigation control across large time and space dimensions (milliseconds to years; centimeters to AUs)

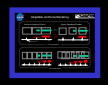
Scaling control within the environment

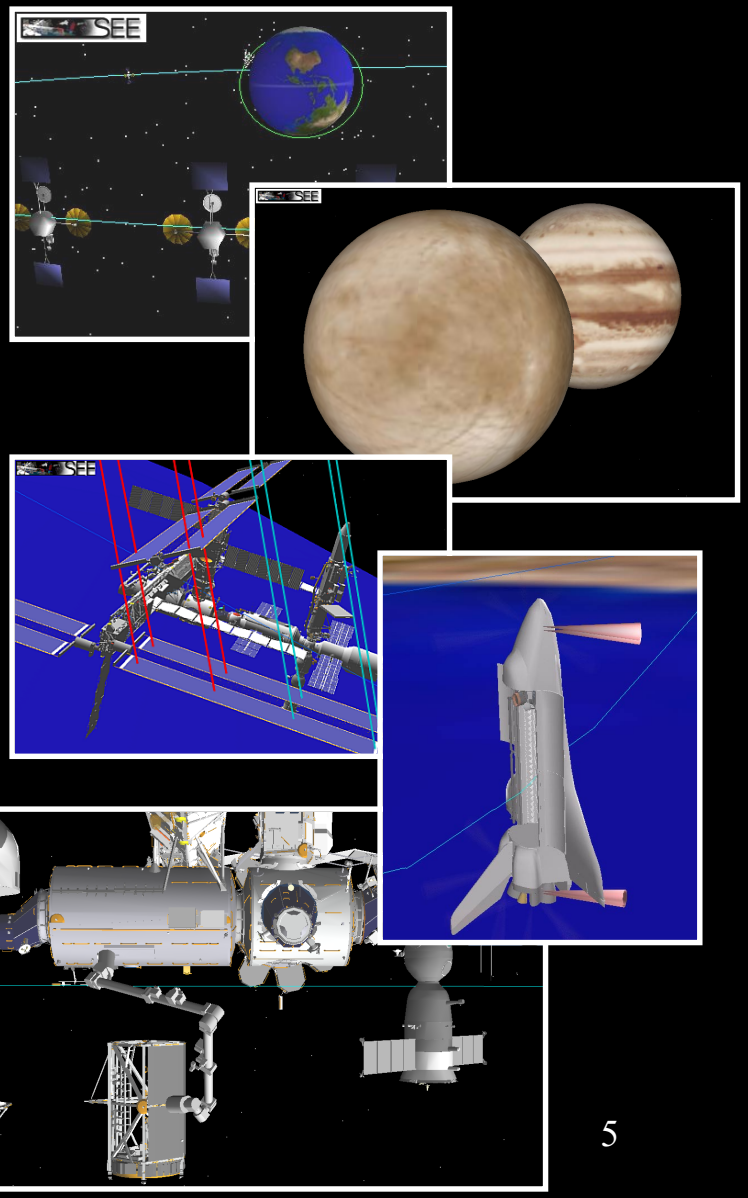
- Maintains analysis integrity (no adverse impact)
- Critical to visualization

Automated processes for import of spacecraft models into the environment

- High resolution CAD models with articulated rigid bodies through custom IDEAS/ProE model export capabilities
- Fast path to analysis (CAD → STL → SEE)
- Artists' conceptual models

Analysis capabilities

- Collision detection/proximity measurement
- Power Subsystem analysis
- Line of sight viewing
- Thruster firing visualization 
- Supplemental data visualization
- Inverse and forward kinematics for robotic operations
- Manipulate geometry models



Trajectory Visualization

Crafts can be placed in the SEE using:

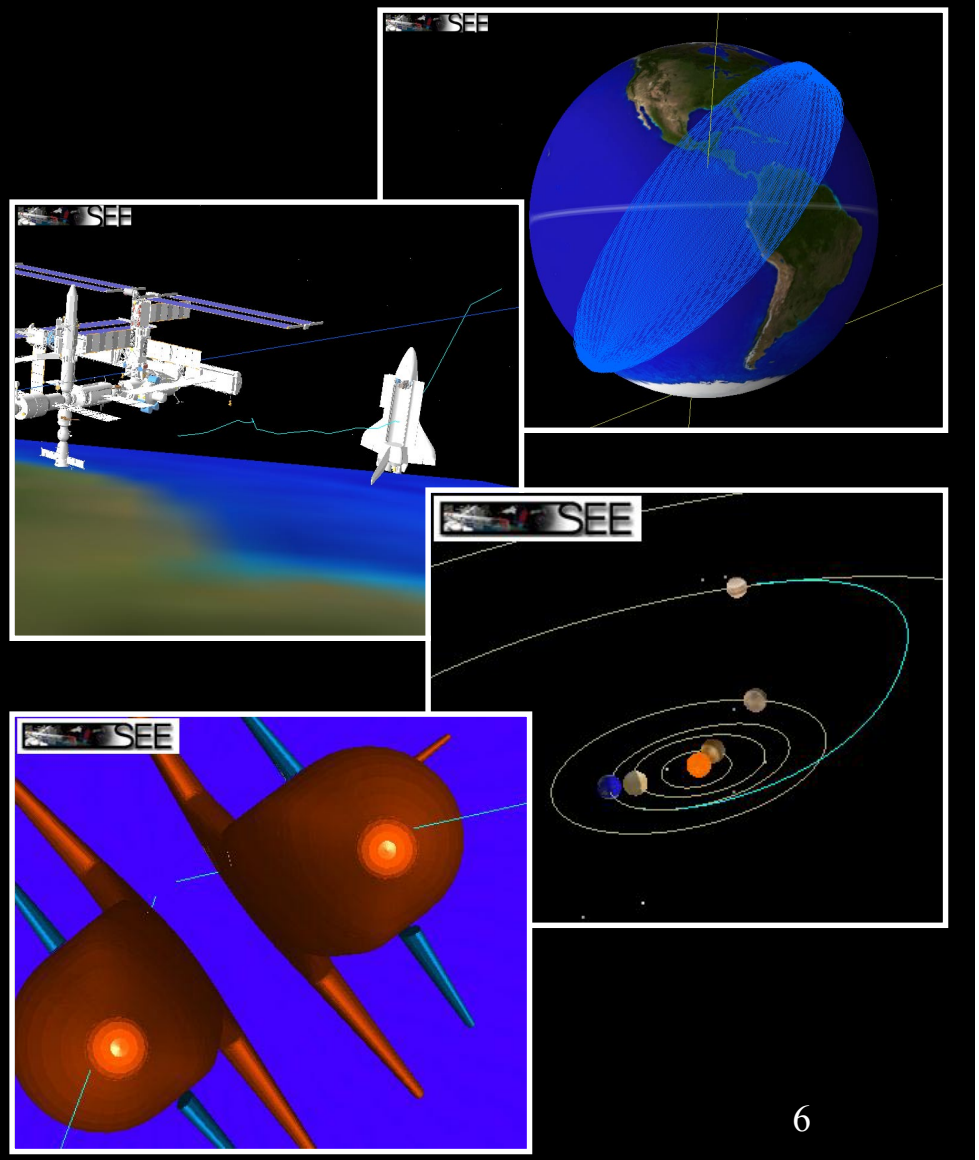
- Classical six orbital elements
- Two Line Element Set using SxP4
- Imported analysis data
- Archived telemetry data
- Integrated ARCD software

Trajectories can be imported:

- Relative to any primary
- Relative to any point
- Relative to another craft (prox ops)

Rigid bodies can be articulated using:

- Imported analysis data
- Auto-suntracking feature
- Scripted motion interface



Enhanced Interface Capabilities

Navigation and Time controls

- Attach your camera to any reference frame
- Bookmarks save time and position
- VCR-style time controls

Icons

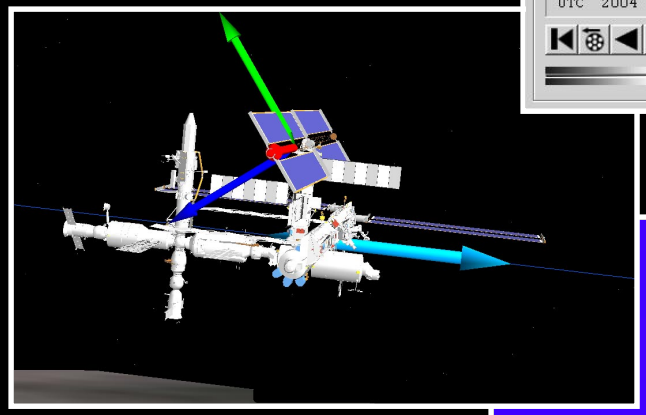
- Reference frame visualization
- Velocity direction vectors
- Object direction vectors

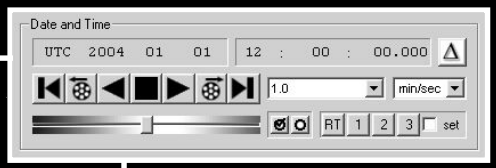
Plotting

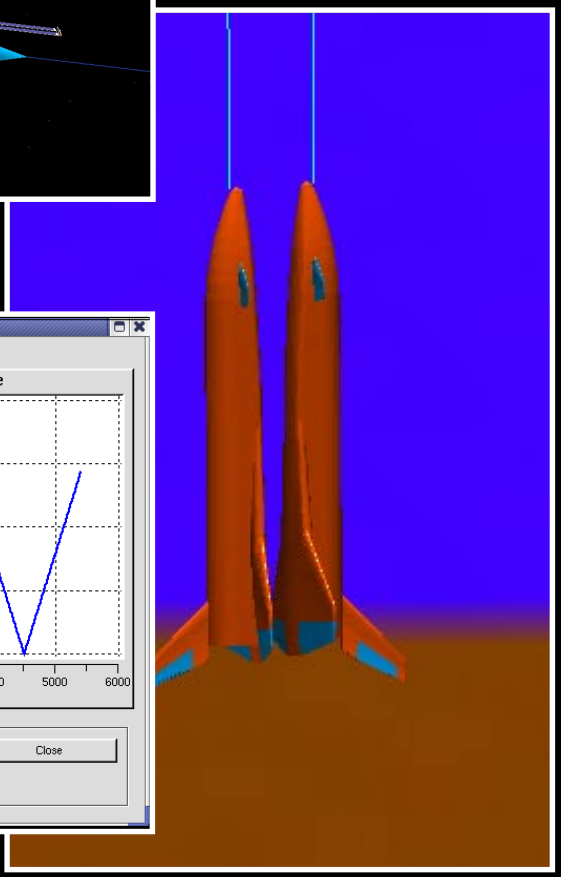
- Time bar shows the simulation's current location within the plot
- All plot data is saved to file for any external plotting needs
- Plot the Euler sequence between two reference frames
- Plot the angle between vectors
- Plot a jet firing history

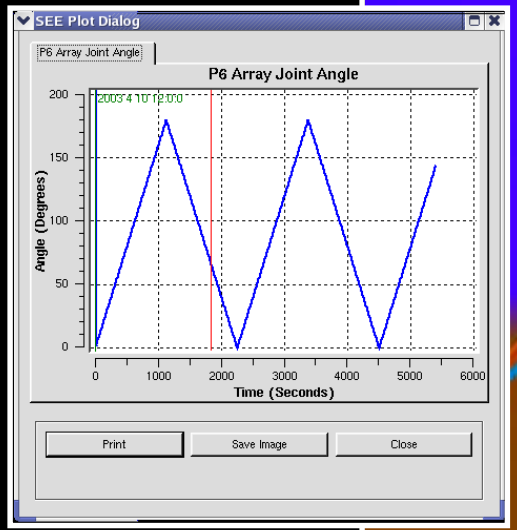
Media

- Still image capture (jpeg, gif, bmp, etc.)
- Time based motion capture (avi)









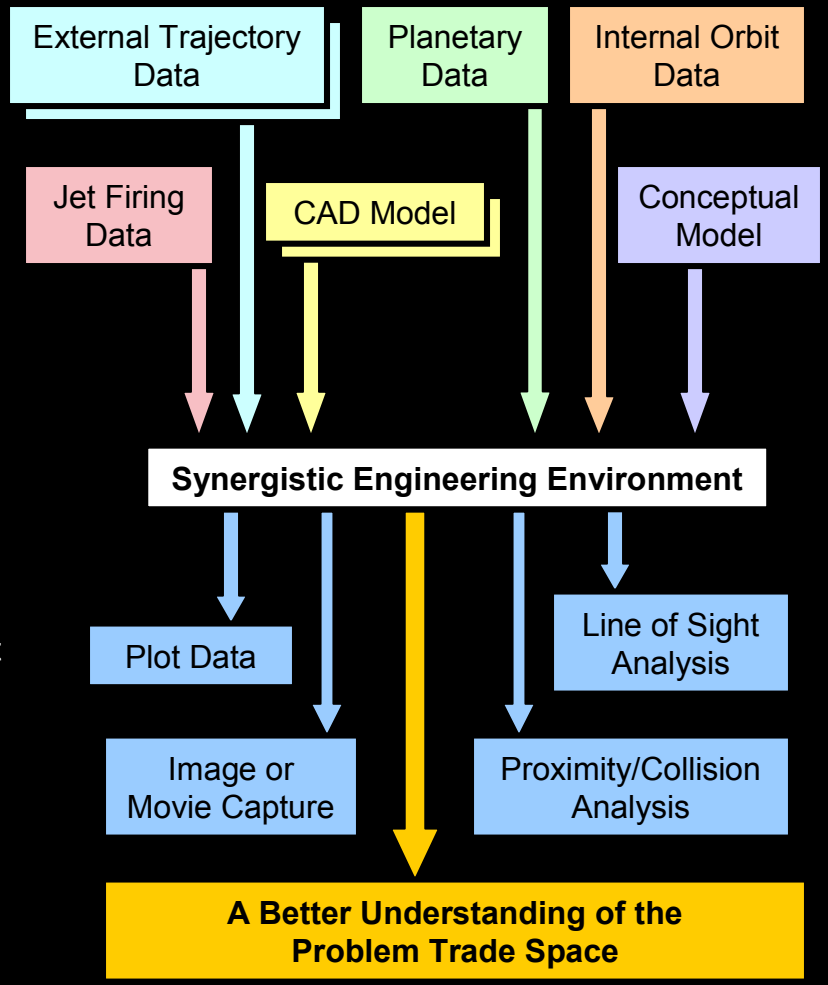
Extensible Architecture Design

Flexible and Robust

- Object Oriented software design
- Cross platform **Windows, Linux, and Irix**
- Scalable from laptops to high end workstations

End-User Customization

- Any number of crafts or other objects
- Each object can have its own unique dynamics model
- Imported data can be viewed relative to an inertial point or within the integrated solar system
- Customizable solar system
  - Any number of planets and moons
  - Internal dynamics model or imported data
- Design analyses with internal macro language



Applications

International Space Station

- Multiple Installations within the VIPER Team
- Multiple Installations within Mission Operations and Lockheed

Architectures, Missions, and Science Branch

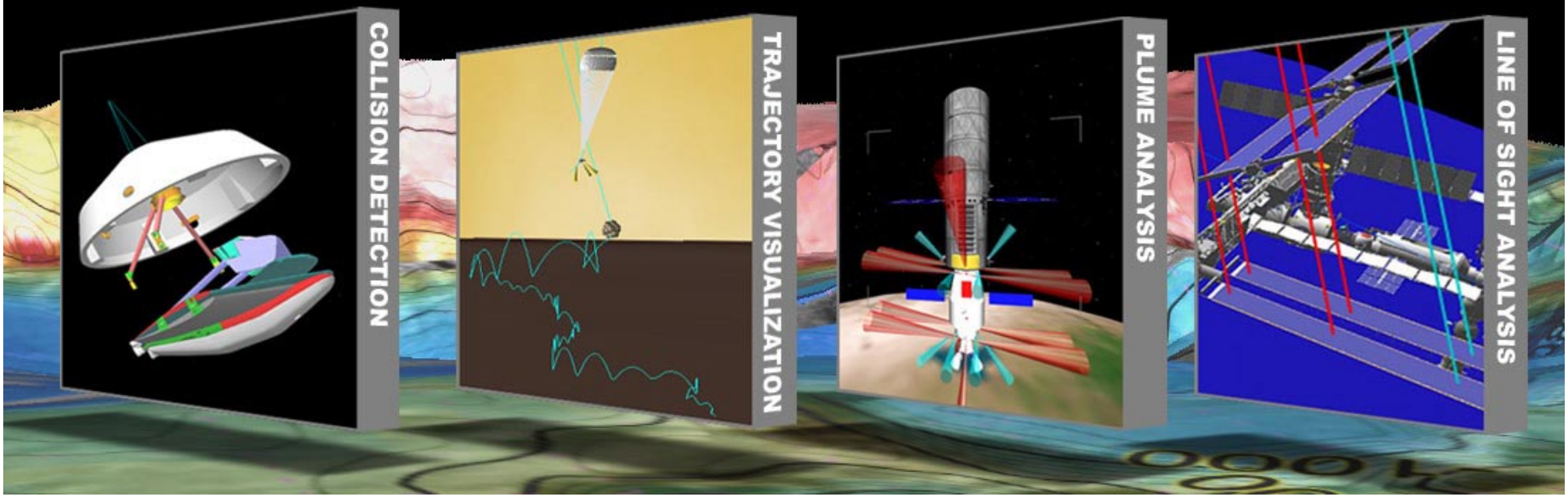
- Support ISS reconfiguration analysis
- Visualization and Analysis of several RASC studies
- Visualization of Lunar Mission Studies

Vehicle Analysis Branch

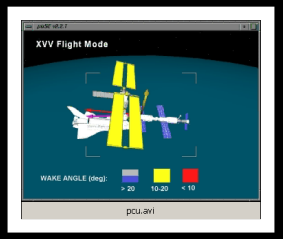
- Mars Scout ARES Separation Analysis
- Hyper-X pre and post flight analysis
- NGLT analysis
- MER landing and descent recreation

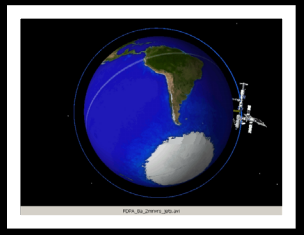
NASA Headquarters

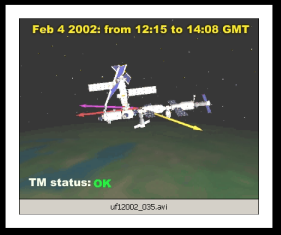
- Installation within the Space Operations Room
- ISS Situational Awareness

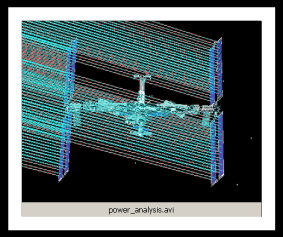


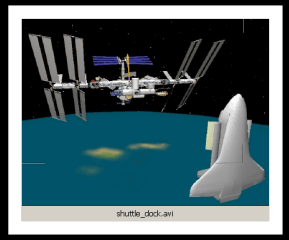
Applications

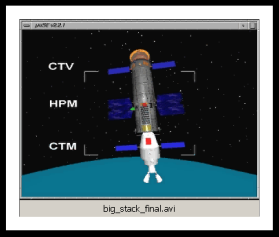


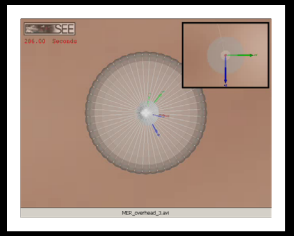


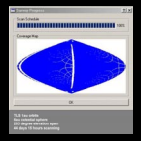


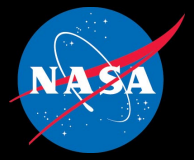




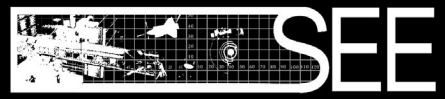








Distinguishing Features



The Unique Capabilities of the SEE Include:

Extensible object oriented code architecture and developer documentation to support new application requirements and integration of existing analysis tools

Automated process for importing object geometry from CAD systems such as IDEAS

Interactive craft assembly manipulation capabilities (e.g. move parts of the craft around to examine instrument placement options)

Macro language for automation of analysis that requires large numbers of repeated trials

High performance rendering to support detailed geometry or large numbers of entities in the scene (e.g. 50,000 asteroids)

Unlimited object scaling (e.g. scaling planets and crafts allows surface features and craft orientation details in the same view)

Novel time-rate controls allow browsing jet firing histories and interplanetary trajectories in the same sim.

Support for unique input file formats and customized planetary body data to allow the analyst to control all objects in the scene using data produced by external tools.

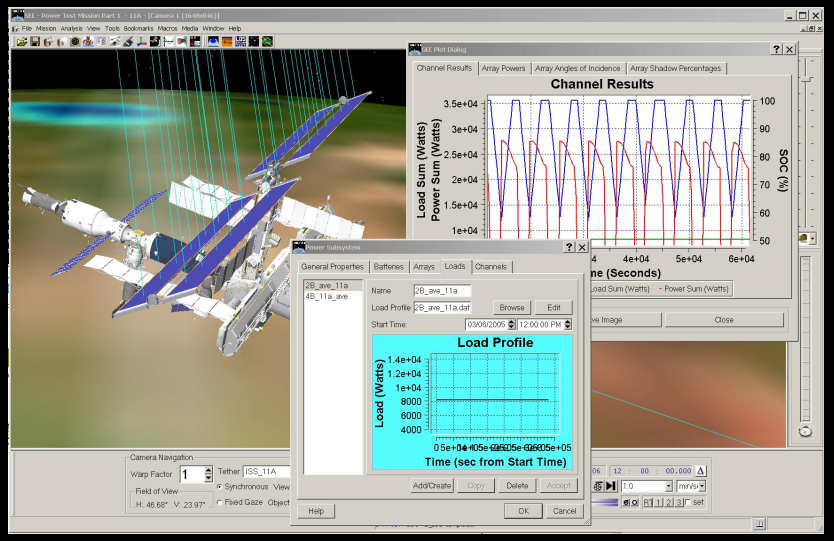
Wide platform compatibility (Windows, Linux, Irix, soon Mac)

Future Directions

Further development and support from ISS Program for subsystem level analysis

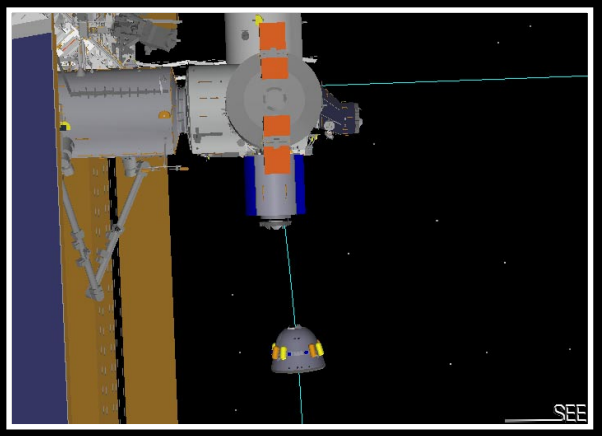
Improved situational awareness

- Real-time telemetry feed
- Enhancements to data visualization
- Ground track
- External camera views
- Real time shadowing



Proximity operations analysis

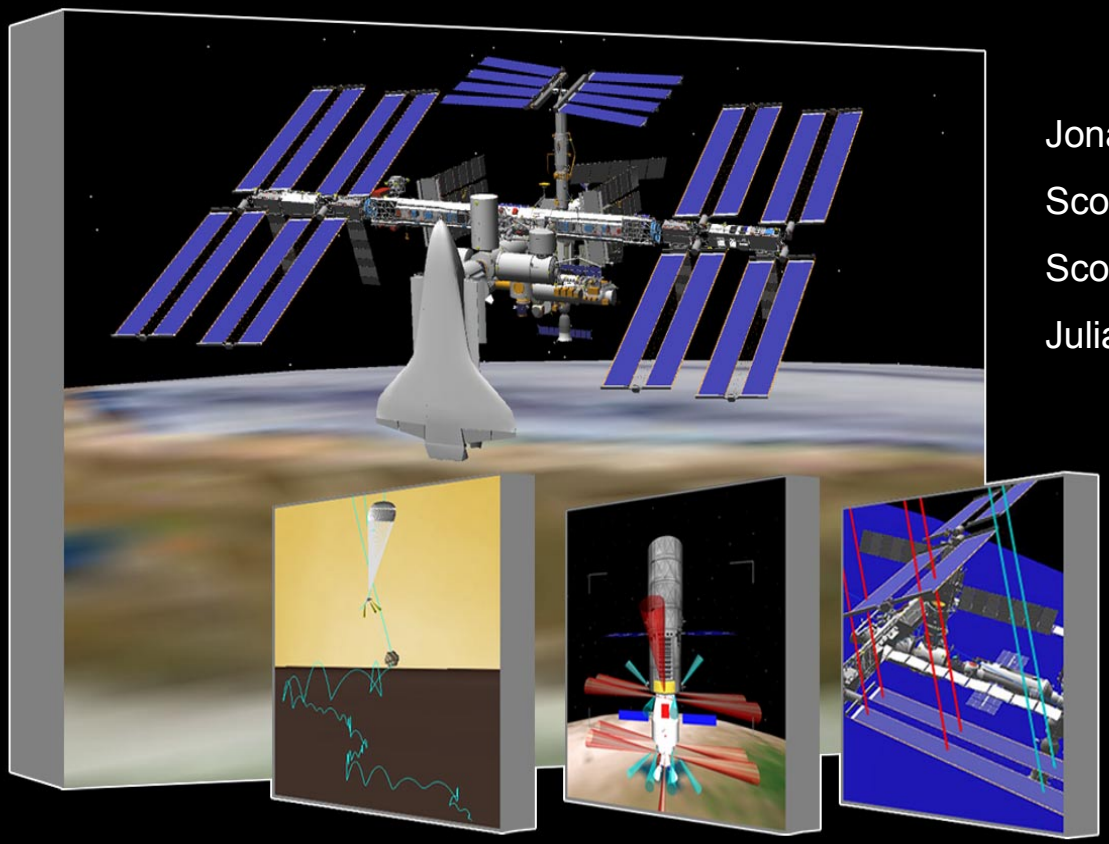
- Integrated 6-DOF docking analysis software
- Visualization of thruster firing data



Distributed simulation capabilities

- Real-time collaboration between SEE users

SEE Team



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